INSTRUCTOR: Steven Majewski (srm4n AT virginia.edu)

OFFICE: Room 251B, Astronomy Building (AST), Telephone: 924-4893, srm4n

OFFICE HOURS: Tuesday, 15:15-16:00, or by appointment.

LECTURE TIME & LOCATION: 14:00 - 15:15 p.m. T, Th in Astronomy Building 265

FINAL EXAM: 09:00-12:00 on Friday, May 1, 2020

COURSE DESCRIPTION

This is a graduate level course focusing on collections of stars as organized into groups having shared or coherent properties, the evolution of these “stellar populations” and how they constitute star clusters, the Milky Way and other galaxies. It will focus on topics mainly internal to the Milky Way and other, resolved, mainly Local Group, galaxies, with a focus on how the observational properties of stellar populations help us to determine the evolution of galaxies. The latter is sometimes called “Galactic Archaeology”, and, when these data are applied to such things as constraining dark matter and the properties of the early universe, “near-field cosmology”. This course is thus complementary to the course Extragalactic Astronomy, which deals with the broader context of galaxies in the universe, unusual galaxies (e.g., AGN), and associated problems on large scales. Obviously there is some overlap between the classes, and hopefully you will see the connections between the “Local Group” and “extragalactic” contexts.

As in many areas of astronomy, the field of stellar populations is experiencing a rapid pace of discovery, partially due to the launch of ESA’s Gaia mission, NASA’s TESS and Kepler missions, as well as new ground-based instrumentation and surveys, such as the UVa-led APOGEE project. I will be trying to update the lecture notes to keep up with the latest in ”Galactic archaeology”, and some of the homework will draw from these datasets. You will be expected to be able to program to complete some of the homework in this class.

PREREQUISITES:

Undergraduates and other students not in the astronomy graduate program should obtain the instructor’s approval to take the class. Students will be expected to know basic astronomy concepts and have an advanced familiarity with the fundamentals of stellar evolution and the HR diagram. We will review these topics only briefly.

THE WEB:

I will use the web as a clearinghouse for class information, including assignments, web links and lecture notes: http://faculty.virginia.edu/ASTR5610/. Your patience is requested as these web pages are updated.

WEB LECTURE NOTES AND CLASS READINGS:

The use of web lecture notes is a tricky issue, because some students like lectures taught from the web, and others do not. Some students feel that by not writing the material down
themselves it is harder to absorb it, that the lecturer tends to go faster, and the lectures potentially speed up. However, I find that it is useful for me to use the web for lectures because I can post complicated figures (which are then also available to you), I can put equations there with less likelihood that I will make mistakes (!), and it helps me to organize my thoughts. Also, the lack of adequate blackboard space in Astronomy Building 265 is a real pain to deal with. Finally, it allows me to post in a central area many things that may not appear in your textbooks, etc. Thus, I will rely on the webnotes, but try to remain engaging enough to keep you awake. As the course is evolving, I also may skip some of the things found in the webnotes, leaving them for you to read.

It should go without saying that your ability to grasp the material and see a broader range of it than I can present in lectures depends on doing the assigned readings.

I’m still recovering from the 2010 hack of the UVa astronomy web server resulted in the loss of all of the course materials (and backups) for this class, including the lecture notes, which are the product of two decades of development. Most of it is back, but a lot is getting revised. I would appreciate knowing when you find a problem in the lecture notes (technical or otherwise).

Given that some of the material this semester will be presented for the first time, I appreciate your patience and understanding that some of it will be freshly put together and may not be as well developed and vetted as older material. Constructive criticism on what works and what doesn’t will be helpful and gratefully received. This will help in the continued development of the course.

ROUGH COURSE TOPICS:

A rough outline of the course (as I see it now and subject to change) will be:

1. Introduction to the concept of stellar populations, challenges to their study, and brief history of the subject
2. Fundamental tools of stellar population studies
3. Review of stellar evolution, tracers of stellar population ages, and other fundamental tools of Galactic astronomy
4. The “simple stellar population” and star clusters
5. More complicated star formation histories (e.g., dwarf galaxies)
6. Stellar abundances and chemical evolution
7. Statistical biases in Galactic/extragalactic astronomy studies
8. Structure, kinematics and evolution of the Galaxy and its stellar populations
9. Galaxies at higher redshift and integrated light studies of stellar populations
COURSE REQUIREMENTS

Your grade will be based on weekly homeworks, a midterm and a final exam. Some assignments will require programming. One or more of the assignments will include working with the APOGEE database.

The midterm will happen sometime “mid-term”, precise date to be determined.

The final exam is Friday, May 1 from 9AM-noon.

TEXTS:

This course will involve readings from the main textbook, Binney & Merrifield’s *Galactic Astronomy*, possible readings from other textbooks (such as Binney & Tremaine’s *Galactic Dynamics*), and published articles from the scientific literature. You can get Binney & Merrifield directly from Princeton University Press, but cheaper used copies can be found on Amazon, eBay, etc. Other books that can be helpful for this class (most of which are available in the library, but also most of which are observationally outdated by various degrees) are:

- *Galactic Astronomy* by Mihalas & Binney (predecessor text to Binney & Merrifield)
- *Galactic Astronomy* by Mihalas & Routly (the grand-daddy of your textbook – observationally outdated but can be useful for its succinct discussion of dynamics).
- *Galactic Structure* by Blaauw & Schmidt (a classic from the 1960s – again, observationally outdated but of historical interest)
- *Stellar Populations* edited by O’Connell (proceedings of the famous 1957 Vatican conference on stellar populations, where many of the ideas of stellar populations were laid out for the first time)
- *Galaxies and Galactic Structure* by Elmegreen (undergraduate level textbook)
- *Galaxies in the Universe* by Sparke & Gallagher (undergraduate level textbook)
- *The Milky Way as a Galaxy* by Gilmore, King & van der Kruit
- *Nucleosynthesis and Chemical Evolution of Galaxies* by Pagel
- *Galaxy Evolution: The Milky Way Perspective* edited by Majewski
- *Globular Clusters* edited by Martinez-Roger et al.
- *Globular Cluster Systems* by Ashman & Zepf
- *SAAS FE 28: Star Clusters* by Carney & Harris
- *The Dynamical Evolution of Globular Clusters* by Spitzer
- *The Road to Galaxy Formation* by Keel
- *Evolution of Stars and Stellar Systems* by Salaris & Cassisi
- *An Introduction to Distance Measurement in Astronomy* by de Grijs
- *Local Group Cosmology*, edited by Martinez-Delgado
ARTICLES:

I am a strong believer in students becoming familiar with historically important journal articles, and I will assign various of these as reading assignments throughout the semester. You should all be familiar with how to retrieve articles from the web or library (!). See the links to the ADS abstract query and astro-ph webpages on the class weblink page.

Other articles that will be helpful guides to some of my lectures are my 1993 article in the ARAA (31, 575), my article in the Globular Clusters volume named above, and my chapter in Local Group Cosmology (Cambridge U. Press, c. 2013). Some of these are linked from the class homepage.

COMPUTING

Some of the assignments will require some programming, so you will be expected to be able to program in some useful language and have access to the computers in the Astronomy Department. You should request a UNIX account and department keys if you do not have them.

POLICY ON SUBMITTED WORK

You are free to consult library/web resources and one another during work on assignments. However, excessive collaboration will obviously be a hindrance to learning the material well (some of which will surely appear on qualifying exams). Any work submitted – i.e., the detailed treatment of a problem – should be entirely your own except in the case of any problems that I allow for a group submission. Penalties will be assessed for late work.

GRADER

We still have no senior graduate student who has agreed to be our grader this semester. However, whether I or someone else grades assignments, please make our lives as easy as possible by turning in assignments on time and neatly organized!